

Attachment 11

COMPASS CALIBRATION PAD (CCP) MAGNETIC SURVEY

A11.1. Contents. This Attachment describes the procedures for performing a magnetic survey for new or existing CCP by a state registered land surveyor. These surveys will determine the following:

- A11.1.1. Suitability of a particular site for use as a CCP.
- A11.1.2. Variations of the magnetic field within the surveyed area.
- A11.1.3. Magnetic declination of the area at the time of the survey.

A11.2. Air Force, Navy, and Marine Corps Requirements. This Attachment does not apply to the Navy and Marine Corps other than to provide applicable Navy publications where additional information may be found. USAF designers may use these criteria or the criteria given in Appendix 4 of FAA Advisory Circular 150/5300-13, Airport Design (see paragraph 6.11.1).

A11.3. Accuracy Requirements. For the purpose of this survey, final calculations should be reported to the nearest one minute (1') of arc with an accuracy of ± 10 minutes (10'). Typically, magnetic variations can be determined to the nearest 30 minutes (30') of arc by using a conventional transit with a compass. The finer precision needed for these surveys may be obtained by taking a minimum of three readings at each site and then reporting their average. All azimuths must be established by the Global Positioning System (GPS) or Second Order Class II conventional control survey referenced to known positions within the North American Datum of 1983 (NAD83) adjustment network, or convert host nation datum to World Geodetic System 1984 (WGS-84).

A11.4. Preliminary Survey Requirements. Preliminary surveys are conducted for proposed sites to assure that the areas are magnetically quiet and thus suitable for a CCP. They are also used to determine if newly constructed items within the influence zone (see paragraph A11.6) of an existing CCP are causing magnetic interference. When siting a new CCP, the location should be chosen such that all separation distances, as defined in paragraph A11.6, are allowed for to the greatest extent practical. A preliminary magnetic survey will then be conducted to determine if the area is magnetically quiet with no natural or manmade magnetic disturbances. When conducting the preliminary survey, the surveyor must immediately notify the agency requesting the survey of any areas they find that are causing magnetic interferences so they can try to identify and remove the interference and they can also determine if the survey should continue any further at that time. The location of the anomaly can be pinpointed by taking readings at additional points around the disturbed area and finding the location with the highest disturbance. If the magnet anomaly cannot be removed and the site made magnetically quiet, then a new site will need to be chosen. One of the following methods is suggested for a preliminary survey.

A11.4.1. Proton Magnetometer Method. A proton magnetometer can be used by walking over the area and making observations approximately every 6 meters (20 feet.) in a grid pattern covering the site. If the values measured do not vary from any other reading by more than 25 gammas for the whole area, then the site can be considered magnetically quiet.

A11.4.2. Distant Object Method. A distant landmark is selected for siting from the various points, 6 meter [20 foot] grid pattern, of the area being checked. A second distant object at approximately 90 degrees (90°) can also be chosen to increase accuracy. The further away the distant object is, the wider an area of points that can be compared to each other and still obtain the accuracy needed. An 8

kilometer (5 mile) distant object will allow a comparison of magnetic declinations of points that are within a 24 meter (80 foot) wide path in the direction of the distant object; while a 24 kilometer (15 mile) distant object will allow a comparison of points within a 73 meter (240 foot) width, or effectively, the whole CCP site. If the magnetic declinations of the different points vary by more than 12 minutes (12') of arc, then the site is not magnetically quiet.

A11.4.3. Reciprocal Observation Method. Several scattered points are selected and marked in the area to be tested. The transit will be set up over one central point and the magnetic azimuth to all of the other points will be determined and recorded. Then the transit will be set up over all the other points and a back azimuth to the central point will be determined and recorded. If there are no magnetic disturbances, then the original azimuth and the back azimuth should be the same for each of the points checked. If there is a difference between the azimuth and back azimuth of any of the points, which is greater than 12 minutes (12') of arc, then the site is not magnetically quiet.

A11.5. Magnetic Survey Requirements. The magnetic survey for the CCP is an airfield engineering survey. AR 95-2 requires that airfield engineering surveys be scheduled on recurring five-year cycles. (The Navy and Marine Corps require annual engineering surveys). This cycle is operationally important, since magnetic north not only varies at different locations on the earth, but it also physically changes as a function of time. It is an operational requirement to calibrate aircrafts' compass correction factors on a regular basis because of these changes. Additionally, the magnetic survey assures that the aircraft will be in a "magnetically quiet zone" which is essential to assure proper calibration of its compass. The magnetic survey for the compass calibration pads must be performed in accordance with paragraph A11.5.

A11.6. Magnetic Survey Procedures. These procedures consist of the magnetic field survey which is used to determine the magnetic declination of a site and the magnetic direction survey which is used to layout the CCP markings. Both a magnetic field survey and a magnetic direction survey of the CCP will be performed every five years or sooner as required by the controlling agency and when magnetic influences have occurred within or adjacent to the CCP. Magnetic influences are considered to be additions of power lines, installation of items containing ferrous metals, or similar activities within an influencing distance of the CCP as defined in paragraph A11.6.

A11.6.1. Magnetic Field Survey (Variation Check). This survey is to measure the magnetic declination within the CCP area. The surveyor will be required to certify that the variations of the magnetic field are within the allowable range and to provide the average magnetic declination of the area. The direction of the horizontal component of the Earth's magnetic field (magnetic declination) measured at any point within a space between 0.6 meters (2 feet) and 1.8 meters (6 feet) above the surface of the CCP, and extending over the entire area of the CCP, must not differ by more than 12 minutes (12') of arc from the direction measured at any other point within this area. All raw data, intermediate computations, and final results will be submitted in a clear, neat, and concise format. The surveyor will accurately layout a 6 meter by 6 meter (20 foot by 20 foot) grid with its center point coincident with the center point of the CCP. The grid will be laid out so the entire area of the CCP plus a minimum of 6 meters (20 feet) outside each edge of the CCP is covered. The grid may be laid out in any direction, but a true north or a magnetic north direction is preferred, since it will simplify the azimuth calculations and allow immediate recognition of points that are outside the allowable declination limits. In any case, the surveyor will have to determine the true azimuth of the grid layout by standard surveying procedures so the azimuth and declination of each point can be determined. After the grid is laid out, the surveyor will check the declination of all the grid points by one of the following methods:

A11.6.1.1. Distant Object Method. A distant landmark is selected for siting from the various points of the area being checked. A second distant object at approximately 90 degrees (90°) can also be chosen to increase accuracy. The further away the distant object is, the wider an area of points that can be compared to each other and still obtain the accuracy needed. An 8 kilometer (5 mile) distant object will allow a comparison of magnetic declinations of points that are within a 24 meter (80 foot) wide path in the direction of the distant object; while a 24 kilometer (15 mile) distant object will allow a comparison of points within a 73 meter (240 foot) width, or effectively, the whole CCP site. If a distant object cannot be chosen far enough away to accurately compare the whole sight (at no time will a distant object be closer than 8 kilometer [5 mile]), then corrections for the eccentricity would have to be made. If the grid were laid out so its center was in line with the distant object and an equal number of points were laid out on either side of this centerline, then this eccentricity would automatically be corrected when the azimuths are averaged. But the points can only be compared to other points within the allowable path width when checking for disturbances in the declinations, unless corrections for the eccentricities are allowed for. The average value is then computed, adjusting for eccentricities if necessary, and reported as the site declination.

A11.6.1.2. Distant Hub Method. After the grid is laid out, additional hubs are laid out a minimum of 90 meters (300 feet) in all four directions from the center point of the grid and designated as "Hub N," "Hub S," "Hub E," and "Hub W." "South Azimuth Marks" are placed perpendicular to the "Hub S," 6 meters (20 feet) apart, and coincident to the grid layout, as shown in Figure A11.1. These azimuth marks will then be used for sighting and taking declination readings. After the grid and azimuth marks are accurately set, the surveyor will set up and level his transit over the center point and sight it on the "Hub S" mark and zero the vernier. The surveyor then must release the compass needle and turn the transit to center it on the compass needle while all the time tapping the compass to minimize friction effects. A reading will be taken here (to the nearest one minute (1')), then deflect the compass needle with a small magnet, realign the transit with the compass and take a third reading. These three readings are averaged to provide the declination for this spot. The surveyor will accurately record the time to the nearest minute for the first and third reading. After the readings are completed for the center point (which will be used for reference), the surveyor will then set up the transit over the other points of the grid and follow the same steps as above while sighting at the appropriate "Azimuth Mark" and determine the declination of each of these grid points. Approximately every 20 to 30 minutes, or any time a reading turns out to be outside the allowable 12 minutes (12') of arc, the surveyor must re-setup over the center point and take new readings to check for diurnal changes in the declination. If readings are found to be outside the allowable 12 minutes (12') of arc, after making corrections for diurnal changes, the surveyor will set up at the bad point and re-check it to see if the results are repeatable. If all the readings are within the required 12 minutes (12') after the surveyor has made diurnal corrections, he then can average these readings and determine the site declination.

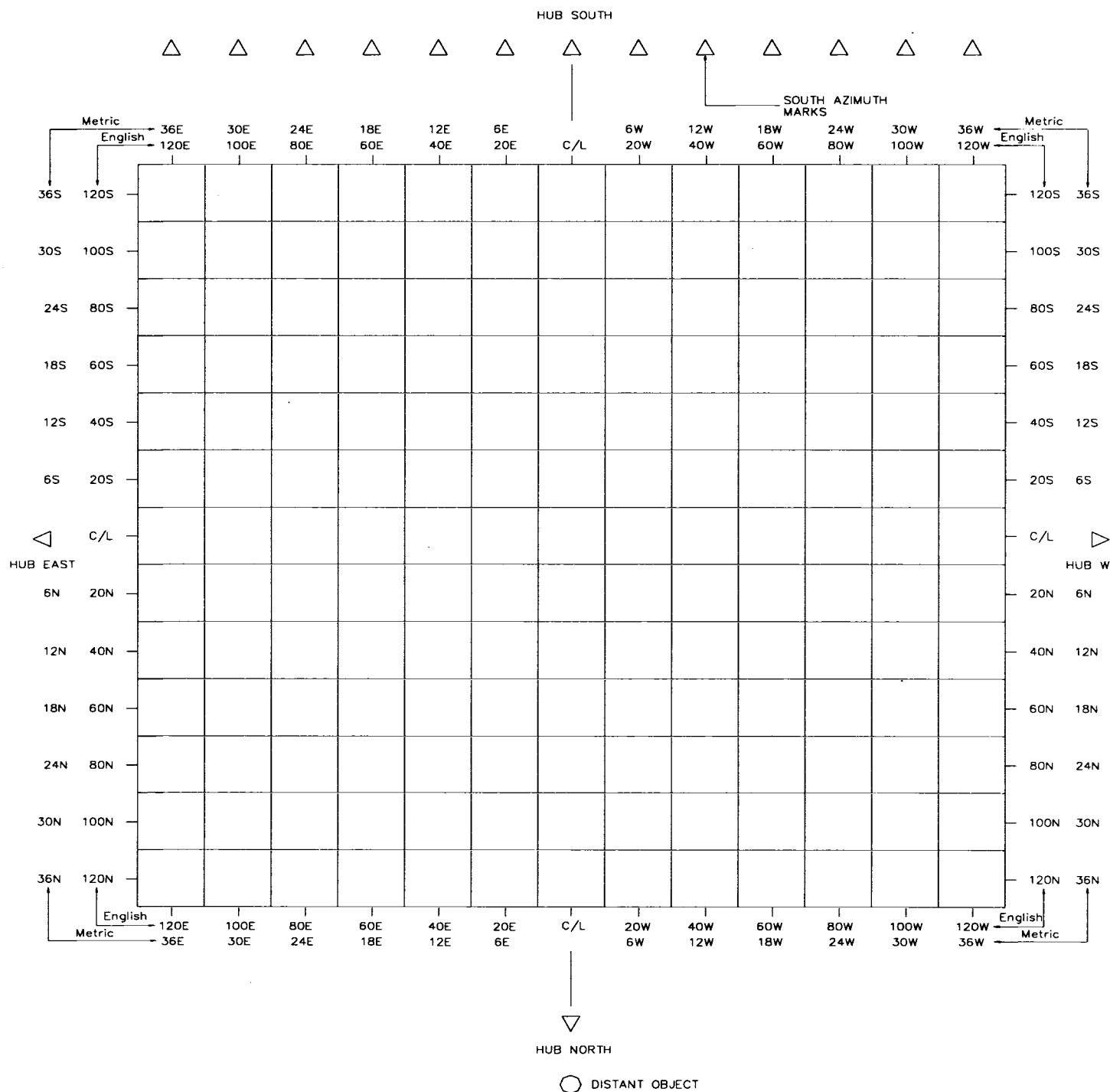
A11.6.2. Magnetic Direction Survey. This survey is to check the layout of the markings at an existing CCP or to lay out the markings for a new CCP.

A11.6.2.1. New CCP. For new CCP, the surveyor will determine the center of the pad and mark it with a bronze surveying marker accurately grouted in place. This point will be stamped "Center of Calibration Pad." After the center point is located and set, the surveyor will accurately locate and set the following control points and pavement markings in a similar manner. See Figure A11.2 for greater detail of the control point layout.

A11.6.2.1.1. True North-South. A north and south control point will be set on a "true north-south" line established through the center of the calibration pad marker. The north-south

control points must be located radially from the center of the compass calibration pad at a distance of 9 meters (30 feet). These points will be stamped "N_T" for the north point and "S_T" for the south point. The markers will also be stamped with "True North (South) - Established 'Day' 'Month' 'Year.'"

Figure A11.1. Magnetic Field Survey Sheet.



A11.6.2.1.2. Magnetic North. A magnetic north control point will set on the "magnetic north azimuth" as determined by the magnetic survey. The magnetic north control point will be located radially from the center of the compass calibration pad at a distance of 12 meters (40 feet). This point must be marked on the pavement with a "N_m" above the point at 12.3 meters (41 feet) radially from the center point and " 'Month' 'Year' " below the point at 11.7 meters (39 feet) radially from the centerpoint. The date will reflect when the magnetic north was established by a field magnetic survey. The markings will consist of 300 millimeter (12 inch) high block numerals with 75 millimeter- (3-inch-) wide orange point stripes. The bronze marker will be stamped with "Magnetic North - Established 'Day' 'Month' 'Year'" and "Declination - 'Degrees' 'Minutes'."

A11.6.2.1.3. Compass Rose Control Points. Twenty-four (24) control points will be provided at 7.5 meters (25 feet) radially from the centerpoint beginning at true north and then every 15 degrees (15°). These points will consist of bronze markers accurately grouted in place. Each of these points will be stamped with their true azimuth (for example 15N_T).

A11.6.2.1.4. Magnetic Compass Calibration Stripes. These stripes are set at magnetic directions from the corresponding true compass rose control point at every 15 degrees (15°). A 150 millimeter- (6-inch-) wide orange stripe will be painted radially from the center of the pad for 7.5 meters (25 feet) for each of the 24 compass rose control points. Each stripe will be bordered by a 40 millimeter- (1½-inch-) wide white stripe. At a distance of 8.2 meters (27 feet) from the center of the pad, in white 600 millimeter- (24-inch-) high block numerals with 0.15-meter- (6-inch-) wide orange paint stripes, paint the azimuth of each stripe as measured from magnetic north. Each orange numeral will be bordered by a 40 millimeter- (1½-inch-) wide white stripe. The layout of the compass rose is detailed in Figure A11.2.

A11.6.2.2. Existing CCPs. For existing CCP, the surveyor will be required to check the alignment of the magnetic north control point and adjust it if necessary. If the average magnetic declination, as determined by a magnetic field survey described in paragraph A11.5.1. above, differs by more than 0.5 degrees (30') from what is marked on the CCP, then the CCP must be re-calibrated. First, all magnetic markings must be removed from the pavement. Then the magnetic north control point marker must be removed and reset to the correct position as described above for a new CCP. The compass rose markings are then laid out and marked as described above for a new CCP.

A11.7. Siting Considerations:

A11.7.1. Separation Distances. To meet the magnetically quiet zone requirements and prevent outside magnetic fields from influencing the aircraft compass calibration, all efforts possible will be taken to make sure that the center of the pad meets the minimum separation distance guidelines.

A11.7.1.1. The minimum recommended separation distances are as follows:

A11.7.1.1.1. 70 meters (230 feet) to underground metal conduits, metal piping (including reinforced concrete pipes), or similar items.

A11.7.1.1.2. 85 meters (280 feet) from the edge of any pavement that is not specifically designed and built for CCP operations.

A11.7.1.1.3. 150 meters (500 feet) to underground alternating current (AC) power lines (including runway/taxiway edge lighting).

A11.7.1.1.4. 185 meters (600 feet) to overhead steam lines; overhead conduits or metal piping; overhead AC power lines; any AC equipment; the nearest edge of any railroad track; the nearest fire hydrant; and the nearest portion of any building.

A11.7.1.1.5. 300 meters (1,000 feet) to any direct current (DC) power lines or equipment (including any underground or above ground telephone lines).

A11.7.1.2. Navy and Marine Corps. For the Navy and Marines, the criteria for separation distances for CCP is given in MIL HDBK-1021/1, *General Concepts for Airfield Pavement Design*.

A11.7.2. Checking Site. Each proposed site for a CCP must be checked for magnetic influence to ensure that the area is magnetically quiet regardless of adherence to separation distances.

Figure A11.2. Layout of Compass Rose.

